REMARKS

The Official Action mailed September 11, 2007, has been carefully reviewed. The claims in the application are now only claims 1, 5 and 8, with claim 5 having been already allowed and the dependent portion of claim 8 having been indicated as being directed to novel and non-obvious subject matter. Applicants respectfully request favorable consideration and early formal allowance.

Claims 1-3 and 13-18 have been rejected as obvious under section 103 from allegedly admitted prior art (APA) in view of JP '334 and Hannig. The rejection is respectfully traversed.

Claim 1 has been amended to incorporate the features of claims 2-4. As claim 4 was not rejected as obvious from APA in view of JP '334 and Hannig, applicants need not address this rejection at the present time.

For the record, however, applicants wish to note that an important feature of the present invention, not previously recited in claim 1, relates to the solid lubricant dispersed in a coating film on a side surface of the piston ring.

That is, distinguishing features of the claimed invention are found in that the piston ring in an internal combustion engine comprises a coating film comprising

(1) a heat-resistant resin binder material, which comprises at least one of a polyamideimide-silicon dioxide hybrid material and a polyimide-silicon dioxide hybrid material, and a solid lubricant dispersed therein on at least one side surface, where

(2) the solid lubricant comprises at least one selected from the group consisting of molybdenum disulfide, tungsten disulfide, boron nitride, graphite, polytetrafluoroethylene resins and tetrafluoroethylene-perfluoroalkyl vinyl ether copolymer resins, and has an average particle size of 0.1 μm to 20 μm, and

(3) the content of the solid lubricant in the entire coating is 5 to 80% by mass,

thereby making it possible to provide a resin coating film for piston rings with improved heat resistance, mechanical strength and adhesiveness to the piston ring substrate, and with reduced hygroscopicity and wear rate (see page 5, lines 18-21 of the specification).

With respect to the distinguishing feature (2) above, it should be emphasized that when the average particle size of the solid lubricant particles is less than 0.1 μm, the

solid lubricant provides poor solid lubrication, and when the average particle size is more than 20 μm, the solid lubricant is so easily detached from the coating film that the coating film is worn out relatively rapidly (see page 8, line 28 to page 9, line 5 of the specification).

However, none of APA such as JP-UM 60-82552 A. JP 62-233458 A, and JP 2001-240670 A teaches or suggests the solid lubricant having an average particle size of 0.1 μm to 20 μm as mentioned in the above distinguishing feature (2) of the claimed invention.

APA such as JP 9-184079 A discloses a coating film comprising a first manganese phosphate underlayer 2 with a larger roughness than those of conventional layers, and a second lubricant layer 3 composed of a heat- and wear-resistant resin such as a polyamideimide, and dispersedly containing a solid lubricant such as MoS_2 having a 1-2μm average grain size (see Abstract with Fig. 1 of JP '079), but JP '079 is silent as to any heat- and wear- resistant resin comprising at least one of the polyamideimide-silicon dioxide hybrid material and a polyimide-silicon dioxide hybrid material as mentioned in the above distinguishing feature (1) of the claimed invention.

Also, although JP '334 teaches only a sliding material obtained by hot pressing a powder mixture consisting

of carbon, amorphous silica and a resin binder in a specified proportion and the addition of silicon dioxide, molybdenum boron nitride, etc. as a friction modifier to the composition thereof (see Abstract of JP '334), JP '334 is silent as to the average particle size of carbon and the friction modifier to be used as mentioned in the above distinguishing feature (2) of the claimed invention.

Further, Hannig teaches a piston made from an aluminum alloy and having a running layer covering at least 80% of the running surface of the piston, where the resin-bound graphite forming the running layer includes graphite particles having a size between 1 and 10 microns and the resin-bound graphite has a graphite content between 30% and 60% (see Abstract; and column 1, lines 48-54 of Hannig).

However, Hannig is silent as to any heat-resistant resin binder material comprising at least one of a polyamideimide-silicon dioxide hybrid material and a polyimide-silicon dioxide hybrid material as mentioned in the above distinguishing feature (1) and any critical size of both a lower limit of an average particle size of 0.1 μm and an upper limit of an average particle size of 20 μm as mentioned in the above distinguishing feature (2) of the claimed invention.

Therefore, one of ordinary skill in the art referring APA, JP '334 and Hannig at the time the present invention was made would not have been able to reach an idea of the coating film with the distinguishing features (1) and (2) of the claimed invention by modifying the teaching of APA with the teaching of JP '334 in view of the teaching of Hannig for the purpose of achieving a coating film of the claimed invention; and, accordingly, claim 1 would not have been obvious over APA in view of JP '334 in view of Hannig.

Claims 1-3 and 13-18 have also been rejected as obvious under Section 103 from Onoda in view of APA and Hannig. This rejection also is respectfully traversed.

Again, claim 4 has not been included in this rejection, so applicants need not respond to this rejection at the present time.

For the record, however, applicants respectfully note as follows. Onoda USP 5,531,195 (Onoda) teaches a piston ring main body 1a having a ring shape; an anti-abrasion surface treatment layer 6 (wear-and abrasion-resistant surface treatment layer) formed at a lower surface 3a of the piston ring main body 1a; and a polybenzimidazole resin coating film 7 including solid lubricants, formed on a surface 6a of the anti-abrasion surface treatment layer (see column 2, lines 59-

65; and Fig. 1A of Onoda), but Onoda is silent as to any heat-resistant resin binder material, which comprises at least one of a polyamideimide-silicon dioxide hybrid material and a polyimide-silicon dioxide hybrid material, and a solid lubricant having an average particle size of 0.1 μm to 20 μm dispersed therein on at least one side surface as mentioned in the above distinguishing feature (2) of the claimed invention.

Applicants have already commented above on APA and Hannig, and respectfully repeat by reference the comments made above relative thereto.

Claims 1-4, 6, 7 and 13-18 have been rejected as obvious under Section 103 from Onoda in view of Murase 2004/0052649 (Murase) and further in view of Hannig. This rejection is respectfully traversed.

Onoda has been discussed above and its deficiencies pointed out. The comments made above concerning Onoda are respectfully repeated by reference.

Murase[1] discloses a sliding component having a metal base member and a coating layer 17 made of silane-modified resin such as silane-modified polyamideimide resin containing a solid lubricant, such as fluororesin, molybdenum disulfide and graphite in an amount of 2-36 weight percent (see Abstract; paragraphs [0024] to [0026]; Examples 1-6 in Table 1

and Examples 7-9 in Table 2; and Fig. 2 of Murase), but Murase is silent as to the average particle size of the solid lubricant thereof, which is an important characteristics of the claimed invention.

Further, as mentioned above, Hannig is silent as to any heat-resistant resin binder material comprising at least one of a polyamideimide-silicon dioxide hybrid material and a polyimide-silicon dioxide hybrid material as mentioned in the above distinguishing feature (1) and any critical size of both a lower limit of an average particle size of 0.1 μm and an upper limit of an average particle size of 20.

Therefore, one of ordinary skill in the art referring to Onoda, Murase and Hannig at the time the present invention was made would not be able to reach an idea of a coating film with the distinguishing features (1) and (2) of the claimed invention by modifying the teaching of Onoda, with the teaching of Murase in view of the teaching of Hannig for the purpose to achieve a coating film of the claimed invention, and accordingly, the amended claim 1 is not obvious over Onoda in view of Murase in view of Hannig.

Even if the references were obviously combinable, and even if Murase were "prior art", the permutations and combinations are so many that taking the correct bits and

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[1] Murase was filed on June 23, 2003, whereas the present application is entitled to its priority date of July 25, 2002.

pieces from each of the references and putting them together in the correct way to obtain anything even close to what is claimed would be next to impossible. Just as all the numbers of a combination lock are available, picking the right combination without more information is almost impossible. And the problem becomes even greater when the references have conflicting requirements, one example of which is that Onoda requires a polybenzimidazole resin whereas Murase demands a different resin. The person of ordinary skill in the art cannot select one over the other without flying in the face of one of the references.

The claimed invention as set forth in claim 1, incorporating the features of previous claims 2-4, would not have been obvious to a person of ordinary skill in the art at the time the present invention was made. Withdrawal of the rejection is in order and is respectfully requested.

Applicants wish to respectfully traverse certain comments made in the Office Action in paragraph 7 under the heading "Response to Arguments" at page 5 of the Office Action.

First, in this regard, the fact that an advantage would flow naturally from what applicants have done has nothing to do with obviousness, and applicants respectfully

deny that the advantages of the present invention would flow naturally from following the prior art.

Applicants particularly respectfully deny that the selection of PI-SiO_2 or PAI-SiO_2 hybrids would have been obvious from the teachings of the prior art. The rejection states in this regard:

> In this case, applicants admit that PI or PAI-SiO_2 hybrids provide improved mechanical strength and heat resistance while maintaining softness in extensibility. These are benefits, **aside from preventing aluminum adhesion**, which would be desirable when selecting coatings for sliding surfaces such as piston rings. (emphasis added)

Applicants maintain, as mentioned in the last reply at pages 9-12, that applicants' results are highly unexpected, and particularly that it would have been expected, from all that is known in the prior art, that the present invention would **fail**, because the person of ordinary skill in the art would expect that a hybrid material containing SiO_2 would have a greater tendency to absorb moisture, and therefore would not be expected to be satisfactory in the claimed environment. Moreover, Al_2O_3 has a greater hardness than SiO_2, and this provides another reason for expecting relatively poor results. It moreover would have been expected, contrary to what would be desired, that SiO_2 would not prevent aluminum adhesion, and indeed would promote aluminum adhesion. All these reasons

which existed in the prior art teach away from the present invention.

Applicants' specification notes that although much attention has been recently paid to organic-inorganic hybrid materials, which have advantages of both organic and inorganic compounds, polyamideimide-silicon dioxide hybrid materials and polyamide-silicon dioxide hybrid materials would not have been expected to necessarily be satisfactory in aluminum adhesion-preventing effects, despite excellent heat resistance and mechanical strength (see page 4, line 2 to page 5, line 8 of the specification). The paragraph spanning pages 4 and 5 states:

> Despite excellent heat resistance and mechanical strength, ... the polyamideimide-silicon dioxide hybrid materials and the polyamide-silicon dioxide hybrid materials are not necessarily satisfactory in aluminum adhesion-preventing effects.

If the PTO is going to rely on what is stated in applicants' specification as APA, the PTO in all fairness, and under the law, must consider **all** of what is there stated, and applicants respectfully submit that the PTO has not considered, taken into effect, and given effect to the above-quoted paragraph spanning pages 4 and 5 of applicants' specification, because any prior art relied upon must be considered "as a whole", *In re Mercier*, 185 USPQ 774, 778 (CCPA 1975); In re *Wesslau*, 147

USPQ 391, 393 (CCPA 1965); In re *Umbrecht*, 160 USPQ 15, 19 (CCPA 1968).

Simply because the polyamideimide-silicon dioxide hybrid material has a moisture absorbent coefficient lower than that of polyamideimide, and simply because polyamide-silicon dioxide hybrid material has a higher breakage strength and tensile elasticity than polyamide *per se*, both as stated in applicants' specification at page 4 and corresponding to APA, does not mean that these materials could be successfully used in the claimed environment and would provide improved results over the prior art. In this regard, it is well known that Al_2O_3 is more stable and harder than SiO_2, and it would be expected by those skilled in the art that a hybrid material containing SiO_2 would not prevent aluminum adhesion, but indeed would promote aluminum adhesion.

The practical temperature range of a piston is approximately 200-300°C, and the standard free energy of the formation of SiO_2 is -195 to -185 kcal/mole and that of 2/3 of Al_2O_3 is -245 to -240 kcal/mole at the temperature range as such (see English translation of Fig. 4.2 showing the standard free energy of formation of various kinds of oxides cited from "Revised Third Edition of HANDBOOK OF CHEMISTRY, Applied Section, page 243, edited by the Chemical Society of Japan,

and published by Maruzen Kabushiki Kaisha, on August 15, 1980, copy previously filed).

Thus, when a coating layer of the piston ring containing SiO_2 collides with a piston comprising aluminum alloy at a temperature ranging from 200°C to 300°C, it would have been expected by those skilled in the art that the reaction represented by the following formula (1) would or at least might very well take place between the piston ring and the sliding mate ring groove of piston made of the aluminum alloy:

$$4Al + 3SiO_2 \rightarrow 2Al_2O_3 + 3Si \cdots(1).$$

So this reaction would leave one skilled in the art to use heat resistant materials **not** containing SiO_2 to prevent the piston ring from aluminum adhesion.

However, the inventors of the present application have found after intensive research that a polyamideimide-silicon dioxide hybrid material and/or a polyamide-silicon dioxide hybrid material produce unexpectedly improved effects different from what would have been expected as mentioned above.

The bottom line is that a person of ordinary skill in the art would not have come up with the claimed subject matter at the time the present invention was made from considering the prior art in combination. The present

invention may now look to have been obvious, using retrospective analysis, but all the reasons which existed at the time would have lead to the expectation of failure, assuming of course *ad arguendo* that such a skilled artisan would have even thought to put all the elements together in the correct combination.

Applicants believe that all issues raised in the Office Action of September 11, 2007, are addressed above, and that the present application should be formally allowed. Favorable consideration and such formal allowance are earnestly solicited.

Respectfully submitted,

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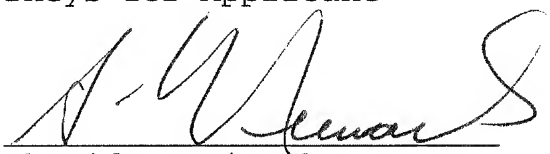
By 
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